

Additional Information

Mass-Energy Equivalence

Einstein's famous equation for mass-energy equivalence is $E = mc^2$. This equation states that the energy contained in matter is equal to its mass times the speed of light squared. Even a small piece of matter, when converted entirely into energy, will yield a very large amount of energy. Some of this energy is contained in the atomic structure of the matter itself, similar to how energy is stored in a spring when it is compressed.

Atoms

Atoms, once thought to be the smallest building block in the universe, are made of neutrons, protons, electrons and the energy that binds these elements together. The mass of an atom is less than the sum of its material components. When you split an atom apart, the total mass of the pieces are more than that of the atom that they made up. This mass difference between an atom and the sum of its parts is small; for example, in the case of uranium-235 it is only 3.18×10^{-24} grams. However, placing that mass, m , into $E = mc^2$ results in a relatively large energy. Consider the significant amount of energy that can be released from the billions of atoms that exist in just a tiny piece of matter.

Chain Reactions

When a neutron is fired at the nucleus of an atom, the atom will break apart. The newly-freed neutrons will go on to hit the centres of two more atoms, which split apart and each hit two more atoms, and so on. Each atom releases a little bit of energy. With each step of the chain reaction, the number of atoms that split increases exponentially which increases the energy released exponentially as well. The chain reaction happens very quickly and the amount of energy that can be produced from such a reaction is very large.

Nuclear Energy

In 1954, the world's first nuclear power plant was constructed in Russia. Today, 15% of Canada's electricity is generated by nuclear power. Nuclear power plants use chain fission reactions to generate heat which boils water, creating steam that spins turbines to generate electrical power. Nuclear power creates fewer green house gases per kilowatt-hour than gas, coal and even solar power. The energy released by a mole of uranium-235 through a fission reaction is 2.1×10^{13} Joules. By comparison, a mole of methane being burned only releases 8.0×10^5 Joules.